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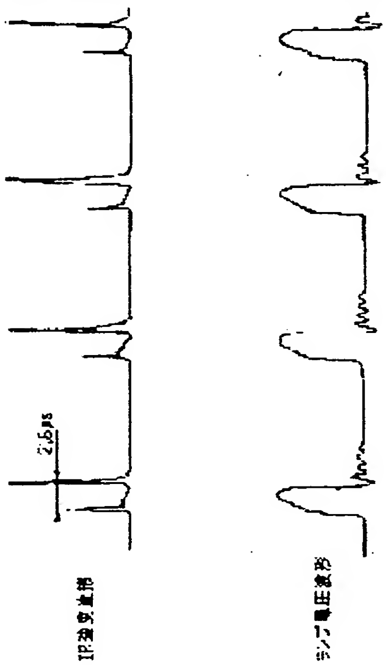
(54) DRIVING METHOD OF RARE GAS EXCUMER LAMP



(57)Abstract:

PROBLEM TO BE SOLVED: To provide a driving method of a gas excimer lamp in which a lamp efficiency is improved by increasing vacuum ultraviolet light generated from excimer in a comparatively short span of time by a plurality of discharges and heat generation from the lamp is lessened.

SOLUTION: A rare gas exciter lamp utilizing light emission from excimer generated by discharge through dielectric barrier with a rare gas with xenon as a main ingredient sealed in a discharge vessel consisting of a dielectric, is driven by separating time-wise various discharge energies according to periodic lamp voltage waveforms. With the above waveforms, if first peak strength is set to h1 and a peak strength after time t1 to h1 the following formula holds good as at least two peak emission strengths of admitted light within the area of 800 nm to 1,100 nm emitted by the above discharge in the above lamp waveforms. $0.5\ \mu s<t1<3.4\ \sigma$ also, h2, h1, or, $h1>2\times h2$, besides, $0.5\ \mu s<t1<2.0\ \mu s$.

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CLAIMS

[Claim(s)]
[Claim 1] The rare-gas excimer lamp using luminescence from the excimer generated by discharge which enclosed the rare gas mainly concerned with the xenon, and minded the dielectric obstruction in the discharge container which consists of a dielectric It is the approach of a periodic lamp voltage wave separating each main stroke energy in time, supplying, and driving a lamp. About at least two infrared luminescence peaks on the strength corresponding to a time change of the total amount of radiation in a 800 to 1100nm [which is emitted to said discharge] field the time of setting reinforcement of the first peak to h1 in time, and setting reinforcement of the peak 1 hour after t to h2 -- h2>h1 and 0.5 microseconds < -- t1 < -- The drive approach of the rare-gas excimer lamp characterized by being referred to as 3.4 microseconds.
[Claim 2] In the rare-gas excimer lamp using luminescence from the excimer generated by discharge which enclosed the rare gas mainly concerned with the xenon, and minded the dielectric obstruction in the discharge container which consists of a dielectric It is the approach of a periodic lamp voltage wave separating each main stroke energy in time, supplying, and driving a lamp. About at least two infrared luminescence peaks on the strength corresponding to a time change of the total amount of radiation in a 800 to 1100nm [which is emitted by said discharge] field the time of setting reinforcement of the first peak to h1 in time, and setting reinforcement of the peak 1 hour after t to h2 -- h1>2xh2 and 0.5 microseconds < -- t1 < -- The drive approach of the rare-gas excimer lamp characterized by being referred to as 2.0 microseconds.
[Claim 3] The drive approach of the rare-gas excimer lamp according to claim 1 to 2 characterized by being the lamp which said rare-gas excimer lamp arranged the fluorescent substance in the interior of a discharge container, and prepared the aperture section for optical ejection.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the drive approach of the rare-gas excimer lamp of washing applications, such as liquid crystal substrate glass, or the rare-gas excimer lamp which carries out light conversion of this vacuum-ultraviolet light, and is used for the manuscript lighting in information machines and equipment, such as facsimile, a copying machine, and an image reader, at the semi-conductor wafer list using the vacuum-ultraviolet light from the excimer generated by discharge through a dielectric obstruction.
[0002]
[Description of the Prior Art] About the drive approach of a rare-gas excimer lamp, the lighting device with sufficient lamp efficiency is indicated by JP,10-223384,A etc. from the conventional sinusoidal lighting as a conventional technique. the inside of JP,10-223384,A, and a paragraph [0010] -- Discharge B -- then, when Discharge C occurs after the extremely short time amount t2, it is indicated that the excimer which generated the excitation kind of the xenon generated by Discharge B in the process which generates an excimer is destroyed by ** and the continuing discharge C. however, one discharge -- then, after short time amount, it could see that the next discharge occurs practically in many cases, and the improvement of the conversion efficiency in such a case was called for. Here, conversion efficiency is the conversion efficiency to excimer luminescence to the power inputted into a lamp. A ramp input will almost become generation of heat, such as loss with a dielectric, and the Joule's heat of discharge, except being changed into excimer light.
[0003] Usually, although luminescence of a rare-gas excimer appears in a vacuum-ultraviolet region, this generation of heat has the problem to which vacuum-ultraviolet light reinforcement falls to since the permeability in the vacuum-ultraviolet region of quartz glass is reduced, and a backwashing rate falls as a result in the application of washing and surface treatment, such as a semi-conductor wafer which uses quartz glass for a discharge container. Moreover, also in the light source for manuscript lighting, the thermal metamorphism of a manuscript, joining to the platen glass of a manuscript, etc. had become a problem by the temperature rise of the platen glass which sets the phenomenon of temperature quenching of the fluorescent substance used for a lamp, and a manuscript by generation of heat of a lamp. For this reason, it was obliged to suppress a ramp input and to sacrifice the need quantity of light conventionally, in order to suppress generation of heat.
[0004]
[Problem(s) to be Solved by the Invention] This invention is made in view of the above-mentioned technical problem, the place made into the purpose increases comparatively the amount of generation of the vacuum-ultraviolet light from the excimer generated by two or more discharge between short time, lamp efficiency is improved, and it is in offering the drive approach of the rare-gas excimer lamp which lessened generation of heat from a lamp.
[0005]
[Means for Solving the Problem] In order to solve this technical problem, it sets to invention of claim 1. The rare-gas excimer lamp using luminescence from the excimer generated by discharge which enclosed the rare gas mainly concerned with the xenon, and minded the dielectric obstruction in the discharge container which consists of a dielectric It is the approach of a periodic lamp voltage wave separating each main stroke energy in time, supplying, and driving a lamp. About at least two infrared luminescence peaks on the strength corresponding to a time change of the total amount of radiation in a 800 to 1100nm [which is emitted by said discharge] field the time of setting reinforcement of the first peak to h1 in

time, and setting reinforcement of the peak 1 hour after t to h2 -- 0.5 microseconds < -- t1 It considers as the drive approach of the rare-gas excimer lamp characterized by being referred to as <3.4-microsecond and h2> h1.

[0006] Invention of claim 2 encloses the rare gas mainly concerned with the xenon in the discharge container which consists of a dielectric. The rare-gas excimer lamp using luminescence from the excimer generated by discharge through a dielectric obstruction It is the approach of a periodic lamp voltage wave separating each main stroke energy in time, supplying, and driving a lamp. About at least two infrared luminescence peaks on the strength corresponding to a time change of the total amount of radiation in a 800 to 1100nm [which is emitted by said discharge] field the time of setting reinforcement of the first peak to h1 in time, and setting reinforcement of the peak 1 hour after t to h2 -- 0.5 second<t 1 < -- It considers as the drive approach of the rare-gas fluorescent lamp characterized by being referred to as 2.0 microseconds and h1>2xh2.

[0007] Said rare-gas excimer lamp arranges a fluorescent substance in the interior of a discharge container, and invention of claim 3 is taken as the drive approach of the rare-gas excimer lamp according to claim 1 to 2 characterized by being the lamp which prepared the aperture section for optical ejection.

[0008]

[Function] Before starting explanation of an operation of this invention, drawing 5 explains the luminescence mechanism of the synchrotron orbital radiation in a 800 to 1100nm field. Most luminescence of this field belongs to transition from a xenon atom. Therefore, you may consider that luminescence of this field has the dominant transition from a xenon atom in mixing with rare gas other than a xenon, for example, helium, neon, an argon, a krypton, etc. The electron in the discharge plasma will collide with a xenon atom, and will be in an excitation state with an expensive xenon atom, and the synchrotron orbital radiation in a 800 to 1100nm field corresponds to the light emitted in case it changes from the high excitation state to a low excitation state here.

[0009] By colliding with the xenon atom of another ground state twice, the xenon atom used as a low excitation state generates a xenon excimer molecule, and emits the vacuum-ultraviolet light near 152nm to 172nm immediately. That is, it is possible by acting as the monitor of the synchrotron orbital radiation in a 800 to 1100nm [from a xenon atom] field to acquire the knowledge about generation of vacuum-ultraviolet light indirectly. There is many scientific reference about this point, for example, it is B.Eliasson. and U.Kogelschatz (299 Appl.Phys.B46, 1988) etc. is mentioned.

[0010] By observing the luminescence peak intensity and time amount decomposition of the synchrotron orbital radiation in a 800 to 1100nm [from this xenon atom] field, following one discharge, artificers found out that there were conditions which generate vacuum-ultraviolet light efficiently, when the next discharge occurred after short time amount. Consequently, it sets to invention according to claim 1. Correspond to a time change of the total amount of radiation in a 800 to 1100nm [which is emitted by discharge] field. When reinforcement of the first peak is set to h1 and reinforcement of the peak 1 hour after t is set to h2 in time about at least two infrared luminescence peaks on the strength, h2>h1 and 0.5 microseconds < -- t1 < -- By having been referred to as 3.4 microseconds, an excimer molecule is dominantly generated from the following peak in the time amount by which an excimer molecule is generated by the first peak. Therefore, the rate destroyed by the first peak with the high energy electron of the excimer molecule in the middle of generation will be stopped low, the amount of generation of an excimer molecule can be increased more, and spark discharge energy can be efficiently changed into vacuum-ultraviolet light from an excimer molecule as a result.

[0011] Moreover, in invention according to claim 2, correspond to a time change of the total

amount of radiation in a 800 to 1100nm [which is emitted by discharge] field. When reinforcement of the first peak is set to h1 in time and reinforcement of the peak 1 hour after t is set to h2 about at least two infrared luminescence peaks on the strength, h1>2xh2 and 0.5 microseconds < -- t1 -- < -- By having been referred to as 2.0 microseconds, an excimer molecule is generated from the following peak in the time amount by which an excimer molecule is dominantly generated by the first peak. And the rate destroyed by the first peak with the high energy electron of the excimer molecule in the middle of generation will be stopped lower, reduction of an excimer molecule can be suppressed, and spark discharge energy can be efficiently changed into vacuum-ultraviolet light from an excimer molecule as a result.

[0012] In addition, the discharge which the generating part within the discharge container of the discharge which generates each luminescence peak on the strength corresponding to the synchrotron orbital radiation in a 800 to 1100nm [from the xenon atom emitted by discharge] field is not necessarily the same, for example, the discharge which generates the first peak is mainly generated near [one] an electrode, and generates the continuing peak may be generated this electrode and near the electrode which counter. That is, although the parts which each peak generates may differ spatially, effectiveness is accepted even if this invention has the difference in such a spatial generation part.

[0013] in invention according to claim 3 , by be the lamp which the rare gas excimer lamp arranged the fluorescent substance in the interior of a discharge container , and prepared the aperture section for optical ejection , in claim 1 list , the vacuum ultraviolet light from the excimer molecule generated efficiently be change into the light with a fluorescent substance , it take out from the aperture section , and the drive approach of the rare gas fluorescent lamp which be the efficient manuscript reading light source which do not contain mercury can be realize by invention of claim 2 in it .

[0014]

[Embodiment of the Invention] In order to estimate the conversion efficiency from electrical energy to the vacuum-ultraviolet light by the excimer molecule, the electrical energy which goes into a lamp first must be estimated. Since one [at least] electrode touches discharge space through a dielectric, the lamp which generally used dielectric barrier discharge cannot estimate the input to discharge simply in a discharge container like the usual lamp which has the electrode of a pair from a lamp current, lamp voltage, a cathode drop electrical potential difference, an anode drop electrical potential difference, etc.

[0015] then -- general -- V-Q RISAJU -- the technique of asking for lamp input power is applied by law with this kind of discharge gestalt. The outline of this approach is shown in drawing 1 . T1 is a transformer and C1 is the integrating capacitor of electrostatic capacity Cm. A Lissajous figure like drawing 7 is obtained from the stored charge Q of C1 (Q=CmxVq) first called for from the electrical potential difference VL of lamp both ends, and the electrical potential difference Vq of C1 both ends. An axis of abscissa is the electrical potential difference VL of lamp both ends, and an axis of ordinate is the stored charge Q of an integrating capacitor. The area S of this Lissajous figure (slash section in drawing) is equivalent to the consumption energy per lamp voltage wave period. If a lamp lighting frequency is set to f here, the lamp power consumption P is calculable by P=Sxf. In addition, the magnitude of Cm is set up so that it may become about VL:Vq=1000:1, and it is considered so that it may not have big effect on a lamp voltage wave. Moreover, although this lamp power P also includes the energy expenditure by the dielectric loss of a lamp, that rate of occupying is small, and especially when explaining the effectiveness of this invention, it does not become a problem.

[0016] Since this approach produces variation in measured value with measuring equipment, such as an oscilloscope, a high-voltage probe, etc. to be used, although the strict nature as an

absolute value is missing, if it is the same system of measurement, it can measure each ramp input enough as a relative value, and is used widely. For example, it is used also for the estimate of the power of each minute cel of AC-PDP (plasma-display panel) which discharges through the same dielectric obstruction as this invention. (119 **** et al., ******A, 31 (1999))

[0017] Drawing 2 shows a sectional view perpendicular to the direction of a tube axis of the rare-gas fluorescent lamp with which this invention is applied. 2 is a discharge container, in 3, fluorescent substance layer, 4, and 4' shows an electrode, 5 shows discharge space, and 6 is the aperture section. The rare-gas fluorescent lamp 1 shown in drawing 2 is made to turn on, and the emission spectrum then obtained is shown in drawing 3 . In this example, LaPO4:Ce+3 and Tb+3 (it calls for short Following LAP) were used as a fluorescent substance. Here, in the case of the fluorescent lamp which uses 254nm for 185nm list from common mercury, with about 172nm vacuum-ultraviolet light, although work important for the energy transfer of Tb+3 in the case of luminescence as a ******** agent of Ce+3 is carried out, in order that Tb+3 may absorb vacuum-ultraviolet light directly, Ce+3 are not necessarily needed. Even when it lessened mol concentration of Ce+3 as much as possible or there was actually nothing, luminescence of the efficient light was obtained by 172nm.

[0018] In drawing 3 , although luminescence from an LAP fluorescent substance is observed near 500nm - 600nm, and it is small also to 800nm - 1100nm, some peak groups P are observed. Drawing 4 is the spectrum Fig. which expanded near 800nm - 1100nm. Most belongs to transition of a xenon atom and these peaks are transition to the low high excitation level of a xenon from excitation level. This point is as having been shown also in drawing 5 .

[0019] Artificers analyzed time amount disassembly of the spectrum of 800nm - 1100nm field in various lamp drive methods paying attention to 800nm - these 1100nm synchrotron orbital radiation. Drawing 6 shows the system of measurement in that case. As a lamp, the rare-gas fluorescent lamp 1 of drawing 2 was used. Since the LAP fluorescent substance of point ** was applied to the lamp, the illuminance was also measured to coincidence with the illuminometer.

[0020] The module (the Hamamatsu photonics company make, form which are henceforth called MD for short: C5331) which used the avalanche photodiode (form by the Hamamatsu photonics company henceforth called APD for short: S2382) was used for observation of 800nm - 1100nm synchrotron orbital radiation. 9 is an oscilloscope and 10 is a lighting circuit. Drawing 8 is an example of the spectral sensitivity characteristic of used APD.

[0021] Next, in order to avoid the light from a fluorescent substance, the infrared light transparency filter (sigma light machine company make, form:TF-50S-76IR which are henceforth called IRF for short) was used between a lamp 1 and APD. Drawing 9 is an example of the spectral transmittance of IRF. It asked for the ramp input of various drive methods by drawing 1 shown previously, time amount disassembly of an infrared (henceforth, IR) spectrum was observed, the illuminance of the light was measured with the illuminometer (the Minolta Camera Co., Ltd. make, form:T-1M which are henceforth called LM for short), and this system of measurement estimated by considering as the index of lamp efficiency by making an illuminance / ramp input into illuminance effectiveness [Lx/W].

[0022] Drawing 10 shows the mimetic diagram which carried out time amount decomposition and expressed the intensity of radiation of 800nm - 1100nm IR observed when the above-mentioned evaluation was performed. In drawing 10 (a), low IR peak appears first and big IR peak appears 1 hour after t. Moreover, in (b), first big IR peak appears and small IR peak appears 1 hour after t. As shown in (c) and (d), also when two or more IR peaks appeared, it was, but paying attention to the peak of A and B by which main spark discharge energies are supplied to a lamp, like a peak like C, or D, even if it did not take especially the peak with it into consideration, it has checked the effectiveness of this invention enough. [small

reinforcement and] [broadcloth]
[0023]
[Example] According to the system of measurement of drawing 6 , it investigated [lamp] about IR peak in various lighting circuits and a list. Drawing 11 shows the example of the lighting circuit used for this invention. Drawing 11 (a) is an example of the circuit by the flyback method. T2 is [a switching element and PC of a transformer and Q1] pulse control systems. An impedance Z is suitably formed by resistance, the coil, and the capacitor from infinity (that is, floating) to zero (gland).
[0024] Drawing 11 (b) shows the self-excitation type sine wave lighting circuit widely used from the former for the example of a comparison. A switching element and C2 are a capacitor and, as for R1 and R2, resistance, and Q2 and Q3 of T3 are the same as that of point ** about a transformer and Z.
[0025] Next, although mainly experimented with the rare-gas fluorescent lamp 1 of drawing 2 about the lighting lamp, there is a lamp which can apply this invention also in other lamps. The lamp of drawing 12 (a) has discharge space 5 in double cylinder tubing as shown in the sectional view of the direction of a tube axis, an electrode 7 and 7' are arranged in the external surface of the discharge container 2 across discharge space 5, and the discharge container 2 is a synthetic quartz glass excimer lamp. Moreover, the lamp of drawing 12 (b) arranges one electrode 8 in the medial axis of the discharge container 2, and the electrode 8 concerned is the excimer lamp which touched with excimer gas through direct excimer gas, and the configuration and dielectric to touch, and arranged electrode 8' of another side in the outside of the discharge container 2. And the lamp of drawing 12 (c) is an excimer lamp of the type which arranged electrode 4' in the internal surface of the discharge container 2, and arranged the electrode 4 in the glass tube outside surface, and can expect the same effectiveness also about these lamps.
[0026] Drawing 13 shows the example of an infrared light wave about claim 1 of this invention. IR peak on the strength appears corresponding to the time of the periodic start of a lamp voltage wave, and falling. That is, a periodic lamp voltage wave separates each main stroke energy in time, and it supplies. The used lamp is the rare-gas fluorescent lamp 1 shown in drawing 2 , and further, the discharge containers 2 are a tube diameter phi 8 and lead glass with a thickness of 0.5mm at a detail, and it is 360mm in overall length. Spreading formation of the fluorescent substance layer 3 of an LAP fluorescent substance is carried out by the thickness of about 50 micrometers at discharge container 2 wall. And 6 is the aperture section in which the fluorescent substance layer 3 is not formed. Although it was set to xenon 13.3kPa, if the input of a drive circuit is chosen, the discharge by which did not become pressurization from near 8KPa where an excimer optical output becomes remarkable, but manufacture of a lamp was stabilized to easy 101.1kPa extent is possible for the filler gas enclosed in discharge space 5. Moreover, mixing with other rare gas is also possible.
[0027] Although the electrode 4 stuck the aluminium tape, it may print and form a silver paste etc. This lamp was turned on by drawing 11 (a). Generally it was called the flyback method and IR peak was observed as an output wave of APD according to the system of measurement shown in drawing 13 during lighting as this circuit was mentioned above. In this example, the lighting frequency to which a main stroke happens was 72kHz, and the average of the ratio of the height of the first IR peak and the following IR peak of the time amount between two IR peaks was 2:5 for 2.8 microseconds.
[0028] Next, the lamp which changes a frequency etc. into a circuit constant, the winding ratio of a transformer, and a list, and shows this lamp to the same drawing 2 in the circuitry of the same drawing 11 (a) was turned on. A result is shown in drawing 14 . Also in drawing 14 , the peak of IR was observed as an output wave of APD. In this example, the time amount between the lighting frequency of 60kHz and two IR peaks by which a main stroke is

generated was 0.9 microseconds, and the average of the ratio of the height of the first peak and the following peak was 5:1.2.

[0029] Moreover, the output wave of APD was observed also about the case of the sine wave widely used from the former. Drawing 15 shows the lamp voltage wave and IR wave by the drive approach of impressing the voltage waveform of a sine wave. A lighting frequency is 25kHz. In the field (N in drawing) to which electrical-potential-difference change serves as max in the case of a sine wave, the continuous IR spectrum was observed and especially regularity was not accepted in the repeat wave [location / of the maximum peak].

[0030] About the flyback method mentioned above, the winding ratio of a circuit constant and a transformer etc. was changed, the lamp of drawing 2 was driven, lamp efficiency [Lx/W] was searched for from the illuminance measured with lamp input power and an illuminometer, and the relation between h1, h2, and t1 was investigated. The relation between IR peak about a flyback method and lamp efficiency and the relation of the lamp efficiency about a sinusoidal method were summarized to drawing 16 in the table. Under the environment with an ambient temperature of 26 degrees C, upstream input voltage was unified into DC24V, and the data of the table of drawing 16 measured it. In this table, the condensed mercury temperature of the lamp measured with the radiation thermometer (the KEYENCE CORP. make, form:IT 2-202, form:IT 2-50) was also shown. The examples of No.1 of front Naka are the drive conditions shown as an example of the conventional technique, No.2, No.3, and No.4 are the drive conditions shown as an example of claim 1, and No.5, No.6, and No.7 are the drive conditions shown as an example of claim 2.

[0031] In the case of h1<h2, in a series of experiments including drawing 16 , IR peak and lamp efficiency were not able to find out causal relation with t1 [clear to the strength and lamp efficiency between IR peaks which get mixed up in time in 3.4 microseconds or more] about t1 at h1 and h2 list. Therefore, it considered as the field shorter than 3.4 microseconds as an upper limit of t1. Although this is indicated by drawing 7 of JP,10-223384,A, if spacing of discharge is set to 3.4 microseconds or more, it will be imagined to relate also to illuminance effectiveness [Lx/W] becoming almost fixed.

[0032] Next, t1 was not able to realize the conditions used as h1>2xh2 from this transformer and pulse control system in 2.0 microseconds or more about IR peak and lamp efficiency. Then, the upper limit of t1 was set to 2.0 microseconds. When t1 investigated the direction which becomes short, in the lamp of drawing 2 used this time, the case where two or more IR peaks appeared [in the case of h1<h2] in 0.5 or less microseconds at a list in the case of h1>2xh2 was not able to be found out. That is, in the field for 0.5 or less microseconds, even if two or more different discharge has occurred as the bottom of the discharge condition in this kind of lamp throughout [discharge sky] in extent which about at most one discharge generates, and this time domain, t1 distinguishes and is guessed that it is difficult to check effectiveness. For this reason, in the case of h1<h2, the list found that it was good to consider as a larger field than 0.5 microseconds as a minimum of t1 in the case of h1>2xh2 about IR peak.

[0033] About IR peak, in the conditions of h1>h2, if set to 2xh2 >=h1, in front Naka of drawing 16 , and the example of No.1 shown as a conventional technique, lamp efficiency has fallen remarkably. This has the large rate that most excimers generated in the discharge in connection with the peak of h1 are destroyed by the discharge in connection with the peak of h2, and is considered for contributing to vacuum-ultraviolet light generating by the excimer which remained by h2. It was considered by the above that the conditions of h1>2xh2 were suitable in respect of lamp efficiency. IR peak as an APD output wave is shown for an example of this conventional technique in drawing 17 . The time amount between the lighting frequency of 98kHz and two IR peaks by which a main stroke is generated in this example was 0.8 microseconds, and the average of the ratio of the height of the first IR peak and the

following IR peak was 6:3.4.

[0034] Next, when the condensed mercury temperature of a lamp is explained, drawing 16 shows that lamp condensed mercury temperature is mostly determined with lamp input power and lamp efficiency. Therefore, there is so little lamp input power that lamp efficiency is good for obtaining the same illuminance, it ends, and lamp condensed mercury temperature can be stopped as a result. That is, lamp efficiency is good at the time of h2>h1, 0.5 second<t 1 <3.4-microsecond or h1>2xh2, and 1< 2.0 microseconds of 0.5 second<t, and can stop the condensed mercury temperature of a lamp at it. Here, in the example of the drive method by drawing 11 (b), since it emanates to continuation in time in spite of observing many IR outputs, an excimer is not generated efficiently but illuminance effectiveness is considered that are bad and generation of heat of a lamp becomes large as a result.

[0035] According to this invention, comparatively, between short time, the amount of generation of the vacuum-ultraviolet light from the excimer generated by two or more discharge can be increased, and lamp condensed mercury temperature can be lowered. Moreover, in this invention, although the relation was described about infrared luminescence of the excitation kind of a xenon, the technical thought of this invention is applicable also about a krypton, an argon, and neon.

[0036]

[Effect of the Invention] As explained above, it sets within a round term of a lamp voltage wave by invention of claim 1. About at least two luminescence peaks of the synchrotron orbital radiation in the 800nm - 1100nm field from the xenon atom emitted by discharge on the strength Since an excimer molecule is generated dominantly from the following peak in the time amount by which an excimer molecule is generated by the first peak The rate destroyed by the first peak with the electron of the high energy of the excimer molecule in the middle of generation will be stopped low, the amount of generation of an excimer molecule can be increased more, and spark discharge energy can be efficiently changed into vacuum-ultraviolet light from an excimer molecule as a result. So, washing and the list for surface treatment can be provided with the lamp drive approach suitable as the light source for manuscript lighting.

[0037] Moreover, it sets within a round term of a lamp voltage wave by invention of claim 2. About at least two luminescence peaks on the strength corresponding to the synchrotron orbital radiation in the 800nm - 1100nm field from the xenon atom emitted by discharge An excimer molecule is generated from the following peak in the time amount by which an excimer molecule is dominantly generated by the first peak. The rate destroyed by the first peak with the electron of the high energy of the excimer molecule in the middle of generation will be stopped lower, reduction of an excimer molecule can be suppressed, and spark discharge energy can be efficiently changed into vacuum-ultraviolet light from an excimer molecule as a result. So, washing and the list for surface treatment can be provided with the lamp drive approach suitable as the light source for manuscript lighting.

[0038] The vacuum-ultraviolet light from the excimer molecule efficiently generated by invention of claim 3 can be changed into the light with a fluorescent substance, it can take out from the aperture section, and the drive approach of the rare-gas fluorescent lamp which is the efficient manuscript reading light source which does not contain mercury can be offered.